REMARKS

The Examiner is thanked for the due consideration given the application.

Claims 18, 20, 21, and 24-38 are pending in the application. By this amendment claims 22 and 23 have been canceled and their subject matter has been generally incorporated into claim 1. Claims 35-38 are new. New claim 35 finds support at page 3, lines 1-4 of the specification. New claims 36 and 37 find support at page 4, lines 16-17 of the specification. New independent claim 38 generally corresponds to claim 18 and finds additional support at page 3, lines 21-26 of the specification.

No new matter is believed to be added to the application by this amendment.

Rejection Under 35 USC §112, Second Paragraph

Claim 34 has been rejected under 35 USC §112, second paragraph as being indefinite. This rejection is respectfully traversed.

The Office Action asserts that the "*and/or*" language is indefinite. However, this language has been removed from claim 34 and replaced with language that is clear, definite and has full antecedent basis.

This rejection is believed to be overcome, and withdrawal thereof is respectfully requested.

Rejection Under 35 USC §103(a)

Claims 18 and 20-34 were rejected under 35 USC §103(a) as being unpatentable over WESTRE et al. (U.S. Patent 6,114,050) in view of FOLKESSON et al. (WO 02/098734)). This rejection is respectfully traversed.

The present invention pertains to a ***laminate*** that is illustrated, by way of example, in Figures 1 and 2 of the application, which are reproduced below.

Fig 1

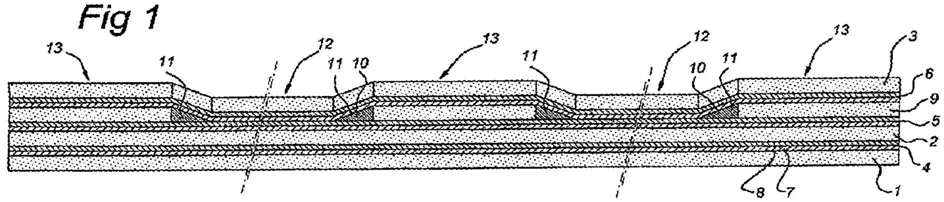
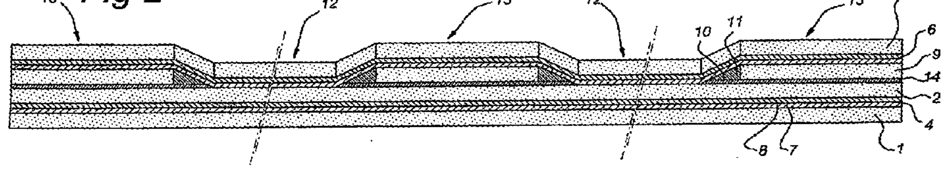


Fig 2

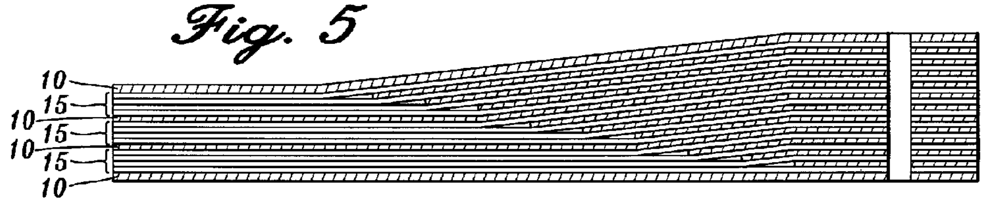


Figures 1 and 2 show metal layers (1-3, 9) and plastic bonding layers (4-6) situated between the metal layers (1-3, 9). Two external metal layers (1, 3) extending substantially continuously, and there is at least one internal metal layer (2, 9). At least one of the internal metal layers (9) has at least one opening (10). Independent claim 18 of the present invention now recites: *"and the metal layer provided with the peripherally closed opening (10) is situated between the plastic bonding layers (5, 6) and is bonded on either side to the plastic*

bonding layers (5, 6), and the plastic bonding layers (5, 6) continue without interruption at a position of the peripherally closed opening (10) and are bonded together at that point."

WESTRE et al. pertain to a titanium polymer hybrid. Figure 5 of WESTRE et al. is reproduced below.

Fig. 5



The Office Action asserts that WESTRE et al. teach the following:

1. a multiple metal layer laminate with adhesive inner layers between the metal layers;

2. a reduction in the number of inner metal layers with a resulting decrease in laminate thickness; and

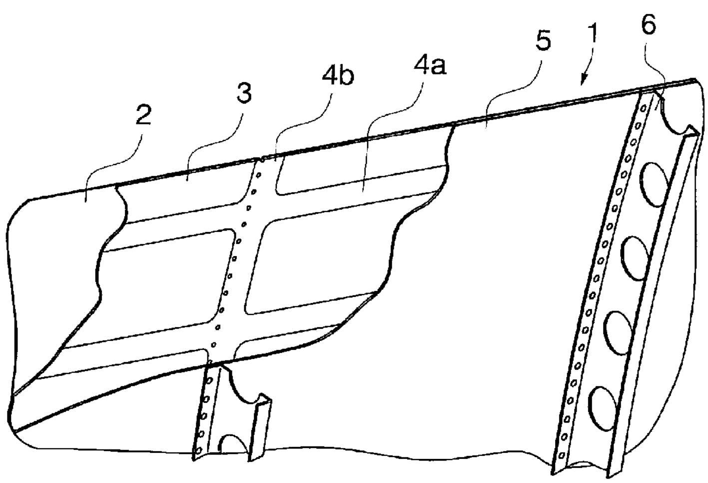
3. the areas reinforced with **extra** layers transfer loads and receive fasteners.

The Office Action then turns to FOLKESSON et al. Before discussing the properties which are ascribed to FOLKESSON et al. by the Office Action, it is noted that this publication does not exhibit any of the three properties 1-3:

Re 1. FOLKESSON et al. do not refer to a laminate, but to a mere "*sandwich*". This can be any stack of layers, which not necessarily need to be interconnected by adhesion. Indeed,

FOLKESSON et al. do not refer to the layers being adhered to each other by adhesives. In any case, there is no plastic bonding layers.

Re 2. FOLKESSON et al. do not show a reduction of the number of inner metal layers: the sandwich is formed from the outer skin 2, the inner skin 5 and a core material formed of the reinforcement grid 4 together with low density core material 3. The reinforcement grid 4 and the core material 3 have a uniform thickness, which does not result in a reduced thickness between the skin layers 2, 5.



From the Abstract of FOLKESSON et al.

Re 3. No areas reinforced with **extra** layers are present in FOLKESSON et al., having regard to the uniform overall thickness of the sandwich.

According to the Office Action FOLKESSON et al. teach:

1. a grid shaped reinforcement member to reinforce areas that receive fasteners; and

2. the grid shaped reinforcement provides reinforced areas to stop crack propagation.

The Office Action then argues that, because of FOLKESSON et al., it would be obvious to form the central metal layers of WESTRE et al. with openings which have closed perimeters in order to form grid shaped areas of reinforcement to hold fasteners to join the panels and prevent crack propagation. The Applicant does not share this view for the following reasons.

First of all, three important differences as listed above exist between FOLKESSON et al. and WESTRE et al. Each of these differences makes a combination of these documents unlikely:

Re 1. A "sandwich" is not the same as a laminate, the latter having a strong adhesive coherence between the several layers whereas the coherence of the "sandwich" is not defined.

Re 2. FOLKESSON et al. aim at obtaining a panel having a uniform thickness, WESTRE et al. has thickened edges.

Re 3. FOLKESSON et al. does not locally add **extra** layers, and WESTRE et al. have locally thickened edges.

Secondly, even in case a combination of WESTRE et al. and FOLKESSON et al. would be contemplated, still no laminate as according to the invention is obtained. The Office's suggestion to apply the teachings of WESTRE et al. to any of the central metal layers would result in central layers which each have an opening, however at the same time FOLKESSON et al. prescribes that such opening be completely filled with core material 3. This is so because FOLKESSON et al. regard both the reinforcement grids as well as the foam filling material in the openings of the grid as

instrumental in obtaining a sandwich construction with the desired properties. In this connection, the passage on page 3, lines 11, 12 of FOLKESSON et al. is illustrative: "*The intermediate aluminium reinforcement panel and the lightweight foam core are distance materials that make the panel act as a sandwich construction*". Also page 4, lines 16-17: "*The core material comprises a distance material that makes the panel act as a damage tolerant sandwich construction*".

The core material of FOLKESSON et al. has the same thickness as the grid structure 4. Applied to WESTRE et al., the core material would have the same thickness as the central metal layer in which the opening has been provided.

Therefore, even in case FOLKESSON et al. would be applied to WESTRE et al., still the feature of a reduced thickness at the openings is not obtained because the openings are completely filled up. FOLKESSON et al. does not contain any indication whatsoever that the grid structure could be applied in isolation, that is without the core material. Quite to the contrary, such isolated application of the grid structure would be in contravention of the teachings of FOLKESSON et al.

Alternatively, the intermediate titanium foil layers of WESTRE et al. could be considered. These intermediate layers are positioned at an edge of the laminate. The intermediate layers end somewhere within the laminate, but they do not extend over the full laminate. At the location of the inner end of the

intermediate layers, the laminate of WESTRE et al. indeed has a lower thickness. In case the teaching of FOLKESSON et al. would be applied to these intermediate layers however, the core material would have to be introduced as well so as to ascertain that the sandwich structure with uniform thickness is obtained (see above).

Thirdly, the Office Action refers to the crack propagating stop feature of the grid structure according to FOLKESSON et al. In this view, that the grid structure in isolation could easily be applied to WESTRE et al., there is no reason as to why and how this crack propagating stop feature is obtained. We refer to page 5, lines 20-24 which clearly indicate that "*The intermediate aluminium reinforcement improves the damage tolerance characteristics in terms of residual strength capability and crack propagation. <u>The panel has a restraining effect on the crack propagation due to the higher panel stiffness and consequently reduced bulging effects</u>. The intermediate aluminium reinforcement provides for a more efficient crack arrest device.*"

The underlined passage shows that the crack propagation restraining feature results from the higher panel stiffness and reduced bulging effects. In connection with the passage indicated before on page 3, lines 11, 12 (the intermediate reinforcement and the core material in combination provide the sandwich construction) and the following passage in lines 16-18: "*The inventive embodiments (i.e., sandwich construction) are arranged to give the fuselage vessel the required stiffness and the*

sufficient amount of material to sustain all aircraft loadings both from static and from fatigue point of view ..." it is taught that the advantageous fatigue properties (crack arrest!) are dependent on the combined application of grid structure and core material. This goes against the assumption of the Office that according to FOLKESSON et al. the grid structure could be used in isolation.

Fourthly, as a further illustration of the fact that WESTRE et al. and FOLKESSON et al. belong to quite different arts, reference is made to U.S. Patent 4,498,325 (RECCIUS et al.) which is mentioned as the state of the art in FOLKESSON et al.

RECCIUS et al. at column 1, lines 24-28 discloses a milled solid aluminium panel. This is not a laminate either. At the time of filing of FOLKESSON et al. (June 7, 2001), the state of the art as disclosed in WESTRE et al. had already been disclosed (September 5, 2000). Yet RECCIUS et al. is considered to be more pertinent to FOLKESSON et al. than WESTRE et al., which is a further indication that FOLKESSON et al. is remote to the field of laminates.

Therefore, one of ordinary skill and creativity would fail to produce a claimed embodiment of the present invention from a knowledge of FOLKESSON et al. and WESTRE et al. A *prima facie* case of unpatentability has thus not been made.

Moreover, the present invention achieves a result that is unexpected in light of the applied art, as is evidenced by the previously filed declaration.

This rejection is believed to be overcome, and withdrawal thereof is respectfully requested.

Conclusion

Prior Art of record but not utilized believed to be non-pertinent to the instant claims.

As no issues remain, the issuance of a Notice of Allowability is respectfully solicited.

The Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 25-0120 for any additional fees required under 37 C.F.R. § 1.16 or under 37 C.F.R. § 1.17.

Respectfully submitted,

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APPENDIX:

The Appendix includes the following item:

☒ - U.S. Patent 4,498,325

United States Patent [19]
Reccius et al.
[11] Patent Number: 4,498,325
[45] Date of Patent: Feb. 12, 1985

[54] METHOD FOR SHAPING PANELS BY A BENDING OPERATION, IN PARTICULAR PANELS FOR AIRCRAFT FUSELAGE SKIN, AND APPARATUS FOR IMPLEMENTING SUCH METHOD

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[73] Assignees: **Walter Eckold GmbH & Co. KG**, Andreasberg; **Dornier GmbH**, Friedrichshafen, both of Fed. Rep. of Germany

[21] Appl. No.: **426,472**

[22] Filed: **Sep. 29, 1982**

[51] **Int. Cl.**^{3} **B21D 11/20**

[52] **U.S. Cl.** **72/302**; 72/379; 72/395

[58] **Field of Search** 72/295, 301, 302, 303, 72/308, 379, 392, 395

[56] References Cited

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2,852,062	9/1958	Lorant	72/302
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Primary Examiner—Lowell A. Larson
Attorney, Agent, or Firm—C. Michael Zimmerman

[57] ABSTRACT

A method is disclosed for bending panels which are provided with reinforcing stiffening ribs. The bending is caused by upsetting or elongating the ribs. Apparatus for carrying out the method also is disclosed and includes means which engage the ribs at points spaced a predetermined distance from the panel skin. The invention is particularly applicable to the shaping of aircraft fuselage skin sections.

10 Claims, 8 Drawing Figures

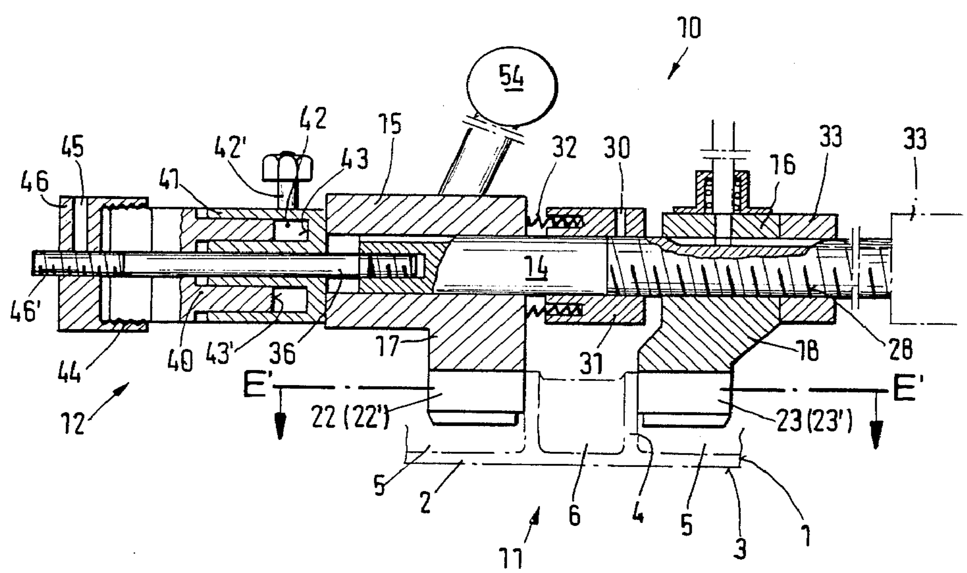


Fig.1

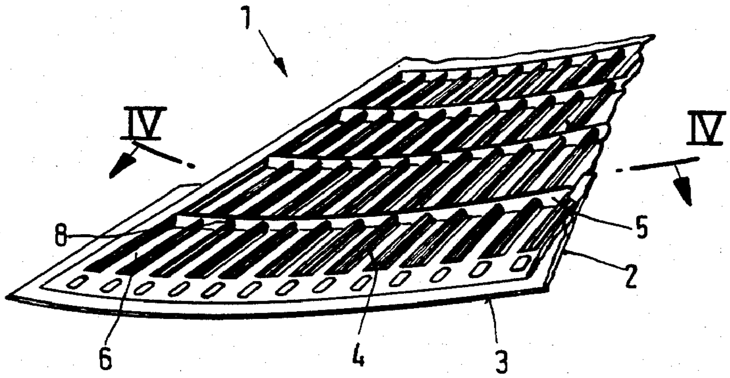
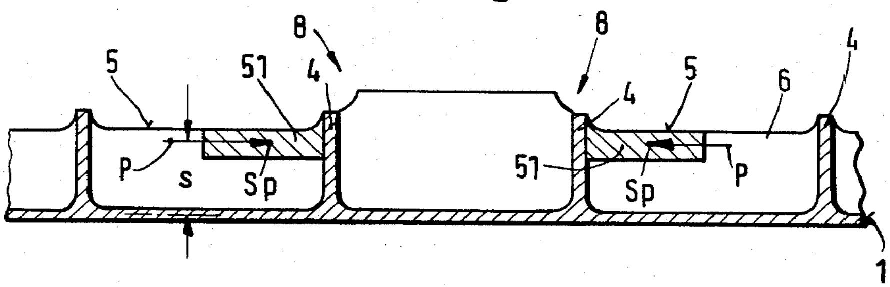


Fig. 4a



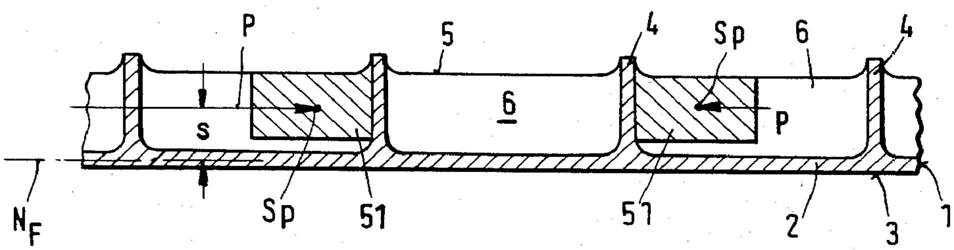


Fig. 4b

Fig. 5

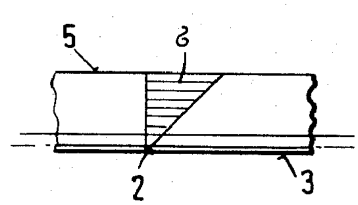


Fig. 2

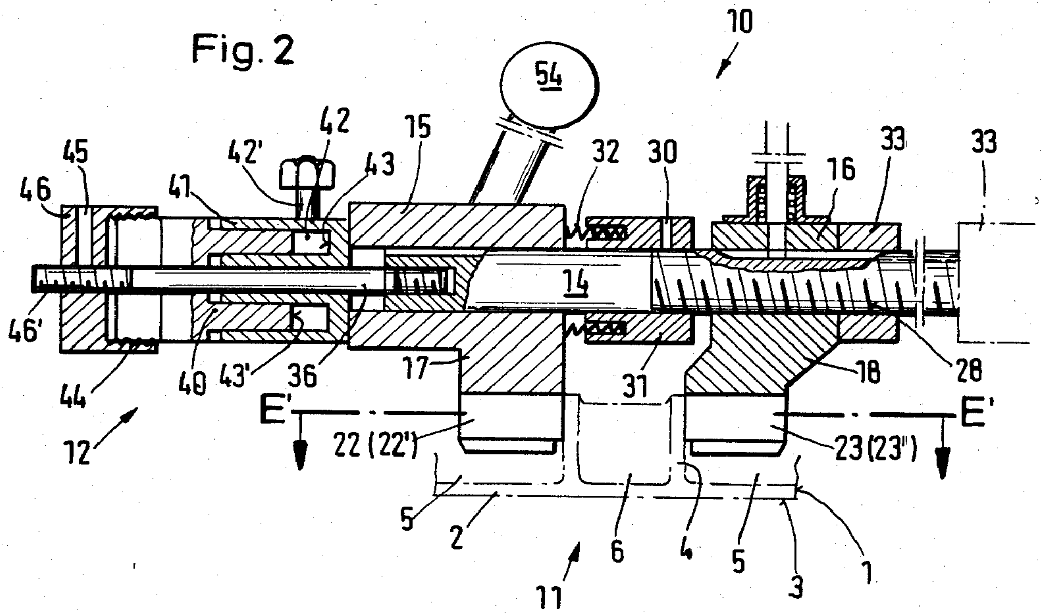


Fig.3

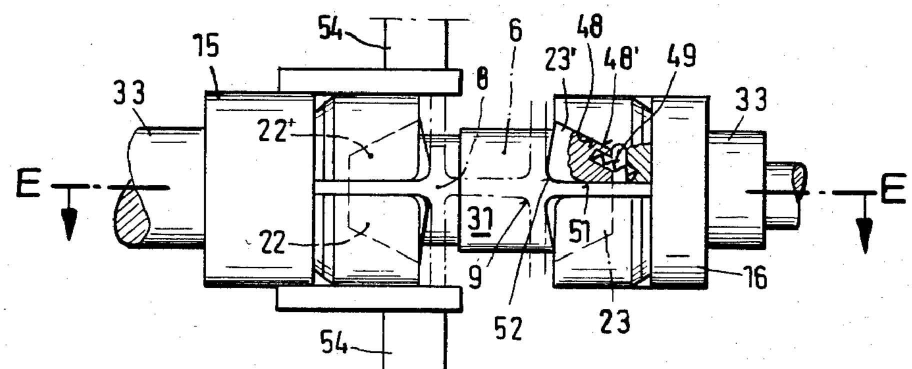


Fig.6

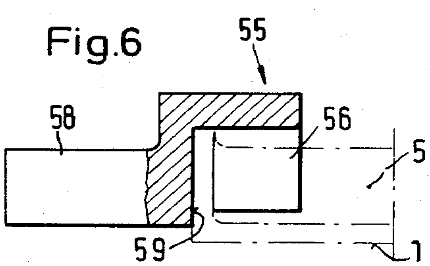
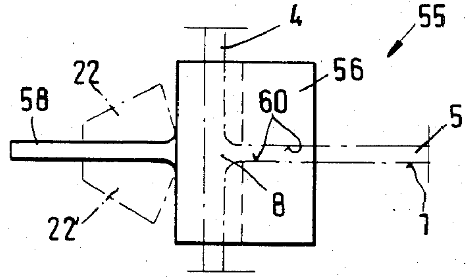


Fig.7



METHOD FOR SHAPING PANELS BY A BENDING OPERATION, IN PARTICULAR PANELS FOR AIRCRAFT FUSELAGE SKIN, AND APPARATUS FOR IMPLEMENTING SUCH METHOD

BACKGROUND OF THE INVENTION

The present invention relates to a method for shaping panels, in particular aircraft fuselage skin sections, by means of bending. Such panels consist of a material which is elastically and plastically deformable, and in case of aircraft fuselage skin sections, is preferably of aluminum.

Aircraft, whether military or civil, must meet extreme requirements. Nevertheless, their manufacture should not involve excessive cost. These somewhat contradictory criteria apply in particular to the manufacture of curved skin sections or panels used for the fuselage, the wings, and other parts of aircraft.

Recent developments in the design of aircraft has resulting in panels or skin sections having an outer skin portion and reinforcing ribs or so-called "stringers" as integrally formed members. By means of modern milling machines, panels having at each point calculated minimum dimensions of skin, ribs and, as the case may be, additional fins intersecting the ribs, may be manufactured of solid aluminum sheet material.

Considerable problems, however, exist in the shaping of such integral panels to a curvature provided in accordance with a given pattern; the combination of skin, ribs, and fins intersecting the ribs, renders these panels very stiff and resistant to deformation.

Several methods are known by which such panels may be shaped: Stretch-drawing, ball blasting, rolling, and whipping. However, these processes involve difficulties when applied to integral panels.

Stretch-drawing results in locally inappropriate deformations unless very expensive apparatus is provided. Ball blasting is suitable only if the skin thickness exceeds a predetermined minimum to allow for the necessary skin dilation. Rolling and whipping are subject to limitations as to the shapes which may be obtained; in particular, there are problems with non-cylindrical or spherically curved workpieces, and this is particularly true when the ribs and fins of the panel have different height dimensions.

SUMMARY OF THE INVENTION

The panel is bent in accordance with the invention by varying, parallel to the skin of the panel, the length of reinforcing ribs, either by upsetting or by stretching them. The ribs are engaged for transmittal of the necessary forces at predetermined points of their height, measured from the skin, such that preferably only bending torques will be developed in the skin so that the area dimensions of the skin will remain substantially unchanged.

An apparatus adapted to transmit the described forces to the reinforcing ribs of the panel briefly comprises two pairs of jaws engaging, at spaced-apart points, one of the ribs, and hydraulic means to move these jaw pairs relative to each other. The stroke of such relative movement is adjustable, as is the distance between the jaw pairs. Thus, the apparatus is very versatile; the jaw pair distance defines the length of the rib over which the adjusted stroke will be effective, and thus the relative upsetting or stretching. No particular

precautions need be provided at the panel, and it is particularly advantageous that the apparatus may be designed so small and compact that it can be manually moved relative to the panel which, preferably, is disposed over a bending template.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** illustrates isometrically an example of a panel to be brought to the shape shown by means of the method of the present invention,

FIG. **2** is a schematized sectional view of a preferred embodiment of the apparatus of the invention,

FIG. **3** is a part of a plan view of the apparatus shown in FIG. **2**,

FIG. **4***a* and **4***b* illustrate, respectively, two positions of the gripping elements when engaging ribs of the panel, the illustration being substantially in the plane indicated IV—IV in FIG. **1**,

FIG. **5** is a diagram illustrating the strain distribution in the panel,

FIG. **6** is a longitudinal section of an auxiliary device to be combined with the apparatus, and

FIG. **7** is a plan view of the device shown in FIG. **6**.

DESCRIPTION OF A PREFERRED EMBODIMENT

FIG. **1** illustrates, as an example, a panel **1** shaped in accordance with the teachings of the present invention. It is a part of an aircraft wing and comprises an outer contiguous skin **2** having an external face **3** and orthogonally intersecting ribs **4** and **5**, respectively, the ribs being integrally formed with the skin **2**. Hereinafter, ribs **4** which extend along the panel will be designated "stringers" while the ribs **5** extending orthogonally with respect to the stringers will be called "fins". Skin and ribs are provided by means of milling operations or equivalent machining, rectangular cavities **6** being formed thereby. The dimensions of skin thickness, rib width and height are determined in accordance with the expected load, and all these dimensions may vary at different points along the same panel. The intersections of stringers and fins result in junctions **8**, the corners of the cavities **6** at such junctions being rounded as at **9** (cf. FIG. **3**).

An apparatus suited to shape such panels will be described below. It is to be noted, however, that this apparatus (and the method associated with it) may also be used for the shaping of panels having stringers only but no fins, or for the shaping of panels comprising a skin part made of sheet material to which ribs are fastened by means of riveting, or by any other means.

Turning now to FIGS. **2** and **3**, the apparatus designated with reference numeral **10** comprises a bending unit **11** and a hydraulically operated actuator **12**. Bending unit **11** comprises a carrier bar **14** supporting two carriers **15** and **16**, respectively. Carriers **15** and **16** are mounted on bar **14** such that their relative spacing is adjustable and the adjusted position may be locked. Each carrier has an arm **17** and **18**, respectively, extending orthogonally with respect to the axis of bar **14** in plane E'—E'.

The arms provide guide means in a common plane E—E for clamping jaw pairs **22,22'** at arm **17** and **23,23'** at arm **18**. Plane E'—E' extends perpendicularly with respect to plane E—E which extends through bar **14** and arms **17** and **18**.

A stop member **31** is disposed on bar **14** between carriers **15** and **16**; member **31** may be adjusted in axial position and may be locked by means of set screw **30**. Carrier **16** is movably disposed on carrier bar **14** and abuts stop ring **33** screwed on the distal end of bar **14** by means of threads **28** which also enable adjustment of the position of member **31**. The other end of bar **14** has an extension **36** which carries the annular piston **40** of hydraulic actuator **12**. Piston **40** is received in hydraulic cylinder **41** and defines, together with the cylinder, fluid chamber **42**. The piston face **43'** and cylinder face **43** are subjected to the pressure of fluid admitted to chamber **42** via inlet and outlet means **42'** which may be connected alternatively to a source of pressurized fluid and a reservoir, respectively, by means of appropriate control valves; such valves are readily available on the market and therefore are not illustrated in the drawings.

The free end of piston **40** is threaded onto connecting member **46** by means of threads **44**. Member **46**, in turn, has screw threads **46'** by means of which it is fastened to extension **36** of bar **14**. Set screw **45** prevents relative rotation of member **46**.

Cylinder **41** abuts axially at carrier **15**. Between the latter and stop member **31**, axially extending compression springs **32** are disposed, the bias developed by said springs serving to hold carriers **15** and **16** spaced apart when actuator **12** is disconnected from the pressurized fluid source.

Arms **17** and **18** have inclined wedging surfaces **48** engaging counter-surfaces **48'** of their respective clamping jaws **22,22',23,23'**. Upon the jaws being engaged over a fin, these wedging surfaces act such that the jaws, when pushed against surfaces **48**, will securely clamp rib **5**. This pushing occurs when the front surfaces of the jaws abut a stringer **4**, rounded edge **52** being adapted to the contour of the rounded corners **9** at intersections **4-5**. Compression springs **49** bias the jaws into their disengaging position, in which their clamping faces **51** are spaced from rib **5**.

The entire apparatus may be handled manually by means of a handle **54**.

FIG. **4** illustrates section views according to line IV—IV of FIG. **1**, parallel to the plane of one of the stringers **4**. Arrows "P" indicate the position of the jaws **22,22'23,23'** where they engage stringer **4** and rib **5**; spaced apart from the neutral axis N_F of the panel skin by a distance s is the surface center Sp assumed at which the power will be injected. Thus, the engaging surface portions of the jaws are cross-hatched in the drawing. It is to be noted that s (the distance between the arrows P and the center plane of the skin **2**) is different in FIGS. **4*a*** and **4*b***, and that consequently even with otherwise identical conditions the bending will affect the individual parts of the panel in quite a different manner.

FIG. **5** is a diagram in which the bending stress and crushing stress, respectively, in skin **2** and ribs **5**, respectively, are indicated. It is to be noted that, with proper election of the spacing s, only minor tensioning or crushing stresses will be developed in skin **2**, or there are even no such stresses at all at least in the neutral axis N_F which is coincident with the skin center plane. The shaping apparatus may be positioned such that this neutral axis will always have the same position with respect to the outer face **3** of skin **2** irrespective of skin thickness variation, with the result that no corrugations will be created on the outer face due to the entire shaping operation.

FIGS. **6** and **7** illustrate an auxiliary device **55** to be used in case of panels where a fin terminates at a stringer. It is evident that under these circumstances, one pair of jaws cannot clamp a fin. Device **55** engages stringer **4** with a transverse face **59**, and it is positioned with respect to the intersection by means of depending portions **56** engaging the lateral rib surfaces **60**. At its opposite end, device **55** has a tail portion **58** having the design and size of a rib **5** so that it may be engaged by the respective pair of jaws **22,22'** or **23,23'**.

The apparatus operates as follows:

At first, the distance between carrier **15** and carrier **16** is adjusted such that their clamping jaws **22,22'** and **23,23'** engage a rib behind its intersection with stringers, at least two stringers being between the carriers. Further, stop member **31** is axially positioned on bar **14** by means of its screw thread and is locked such that a desired shaping stroke may be executed. The actuator is then fed with pressurized hydraulic fluid into its cylinder chamber **42** so that piston **40** is moved and shortens the distance between carriers **15** and **16**. Because of the wedging surfaces **48, 48'** the jaws **22, 22', 23, 23'** will safely grip the rib **5**, and during the piston stroke which is limited by stop member **31** the rib portion between the pairs of jaws will be upset. Upon removal of the pressure in chamber **42**, the carriers will be moved apart because of the bias of springs **32**, and springs **49** will cause disengagement of the jaws from the lateral surfaces of rib **5**.

An expert skilled in the art will easily realize that the device may be modified to shape the panel by means of elongation instead of upsetting.

What we claim is:

1. A method for shaping panels made of a plastically deformable material having both a skin portion and a plurality of intersecting stiffening and secondary ribs on one surface of said skin portion, comprising the steps of transmitting force along said stiffening ribs to plastically vary the length thereof, said force being transmitted to a stiffening rib by engaging the stiffening rib and applying force at the points of intersection between said stiffening and secondary ribs at a predetermined distance spaced outwardly from said skin portion whereby said skin portion is subjected to bending forces without substantial tensioning or crushing stresses being imparted thereto.

2. A method as set forth in claim **1** wherein said predetermined distance is selected such that a neutral axis is at least approximately in the center of said skin portion halfway from said one surface thereof.

3. A method as in claim **1**, wherein the stiffening and second ribs intersect one another orthogonally.

4. A method as in claim **1**, wherein the force is applied on the opposite sides of a pair of said second ribs.

5. An apparatus for the deformation of sheet metal provided with reinforcing ribs extending perpendicularly from one sheet metal surface thereof and extending in a direction in which a curvature of the sheet is to be made, means to alter the length of said ribs to vary the curvature of said sheet metal comprising:

at least two pairs of clamping jaws adapted to engage respectively one of said ribs at spaced apart points,

adjustment means associated with at least one of said pairs of clamping jaws for adjusting the distance by which said points are spaced apart,

power drive means for moving said jaw pairs relative to one another, and stop means for limiting said relative movement.

6. An apparatus as set forth in claim 5 wherein a first jaw carrier for a first pair of said clamping jaws is mounted stationarily on a support, a second jaw carrier for a second pair of said clamping jaws is mounted to be movable along said support by said adjustment means and is lockable at a selected position, a stop member providing said stop means is disposed on said support between said first and said second jaw carriers, and a hydraulic ram provides said power drive means and is adapted to alter the length of said support between said carriers by a distance defined by said stop member.

7. An apparatus as set forth in claim 6 wherein said clamping jaws are supported by said jaw carriers via wedging surfaces such that two jaws forming a jaw pair clamp said rib between them when a force acting in a predetermined direction parallel to said rib is exerted upon their respective carriers.

8. An apparatus as set forth in claim 6 wherein said support comprises: a hydraulic ram cylinder on which said first jaw carrier and a counter stop member are mounted, and a piston which is hydraulically displaceable in said cylinder and has a piston rod which carries said second jaw carrier and said stop member.

9. An apparatus as set forth in claim 7 wherein reset spring means are provided biasing said jaw carriers into their initial position upon deactivation of said power drive means.

10. An apparatus as set forth in claim 5 for deforming panels which have first ribs to be engaged by one of said clamping jaw pairs and second ribs intersecting said first ribs orthogonally, wherein said apparatus has an intermediate force transmitting member engageable over one of said second ribs adjacent one of said intersections and provided with a tail portion to be engaged by the other pair of jaws.

* * * * *